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Tecnologia com Conceitos Ambientais

Regional Workshop on Metrology and Technological Challenges of Climate Science and Renewable Energy 2014

Ethanol, Electronic Management and Flex Fuel Vehicles: Environmental Benefits and the Need of Improvements on Emission Measurements and Test Procedures

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Montevideo, September 2nd – 4th, 2014

Milestones of Ethanol Use and Emission Control

1. 1980 - First ethanol engines: improving efficiency and reducing CO and HC emission;
   - Non controlled carbureted engines: lean mixtures, lowering CO and HC (- 40%);
   - Materials development: corrosion and polymers resistant to ethanol;
   - Reduction of ethanol production waste;
   - Improvement of sugar cane production and biotechnology;
2. 1986 - Emission standards were established for all vehicles – PROCONVE;
   - similar std. for both gasoline and ethanol engines – further emission reduction;
   - 1997 - 3rd phase Otto cycle vehicles target: electronic management and more than 90% emission reduction, including aldehydes;
3. 2000 – 4th phase Diesel HDV target: EURO II std. and ~ 70% emission reduction;
4. 2003 – Start of motorcycle emission program - PROMOT
5. 2004 - enhanced electronic engine management and viable Otto flex fuel vehicles and EURO III std. for diesel HDV;
6. 2009/10 – limits more stringent and introduction of OBD-II;
7. 2012 – EURO V std. for Diesel HDV;
8. Next steps: organic emission control based on ozone formation potential
   enhanced evaporative emission control

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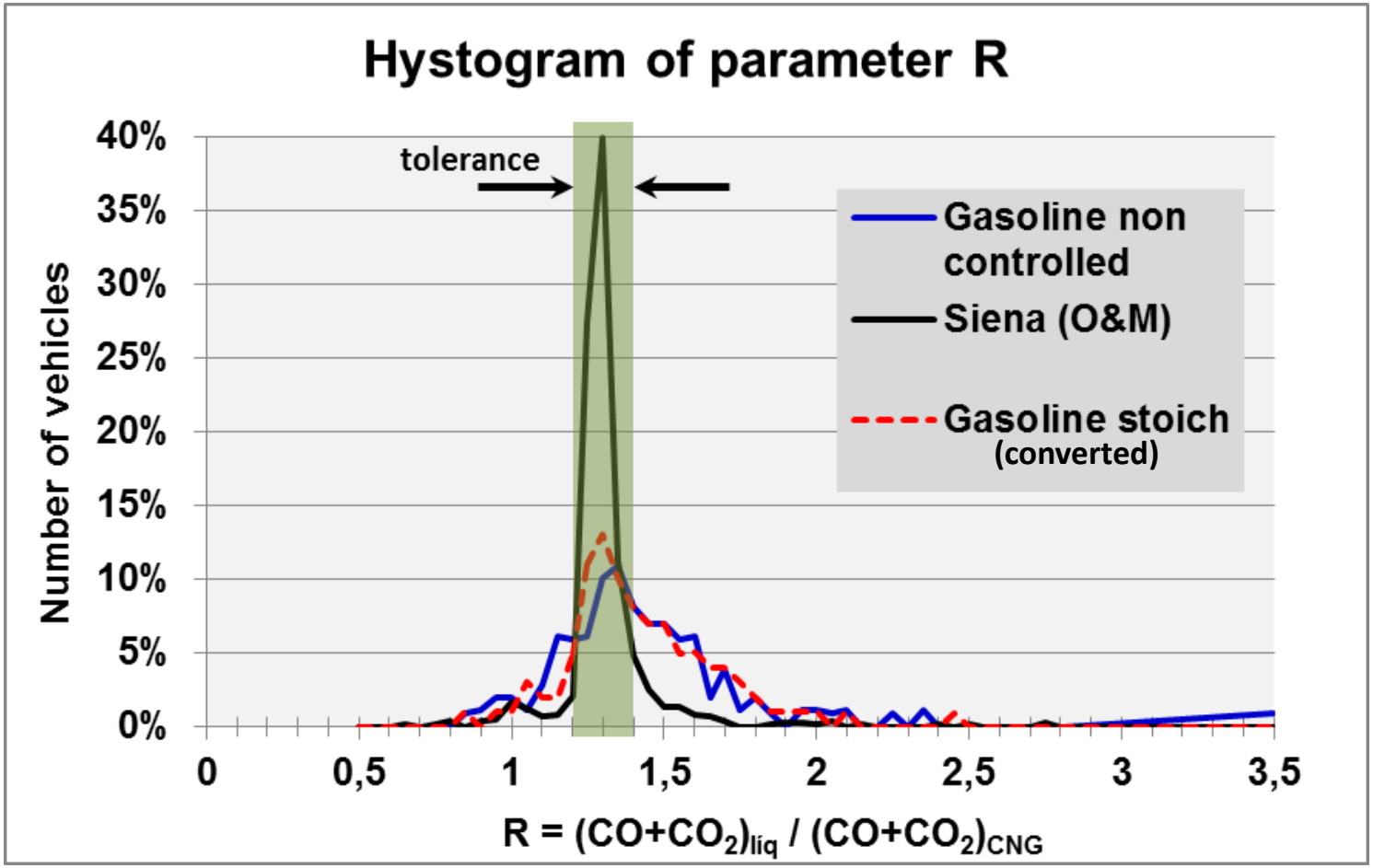
Ethanol Pros and Cons

1. Renewable CO_2 reduces GHG significantly;
2. Reduced evaporative emissions and photochemical reactivity;
3. Lower energy content - compensated by higher compression ratio and spark advance control reduced differences in fuel consumption to 20% when compared to gasoline;
4. Corrosion problems - solved by new materials and reduced electric conductivity of fuel;
5. High aldehyde emissions - reduced by 3-way catalists;
6. Fuel injection improved cold start, but still using gasoline or producing high ethanol emission in the first minutes of driving cycle;
7. Heated injectors reduced unburned ethanol emission during cold start, recently;
8. New polymers solved plastic and rubber parts deterioration;
9. Liquid waste of ethanol production was incorporated in agricultural process and environmental problems became eliminated;
10. Significant energy generation with leaves and stems reduces environmental impacts.

General I&M Results of CNG vehicles



$$\frac{(CO + CO_2)_{Liq.Fuel}}{(CO + CO_2)_{CNG}} = {}^{15}/_{12} = R$$

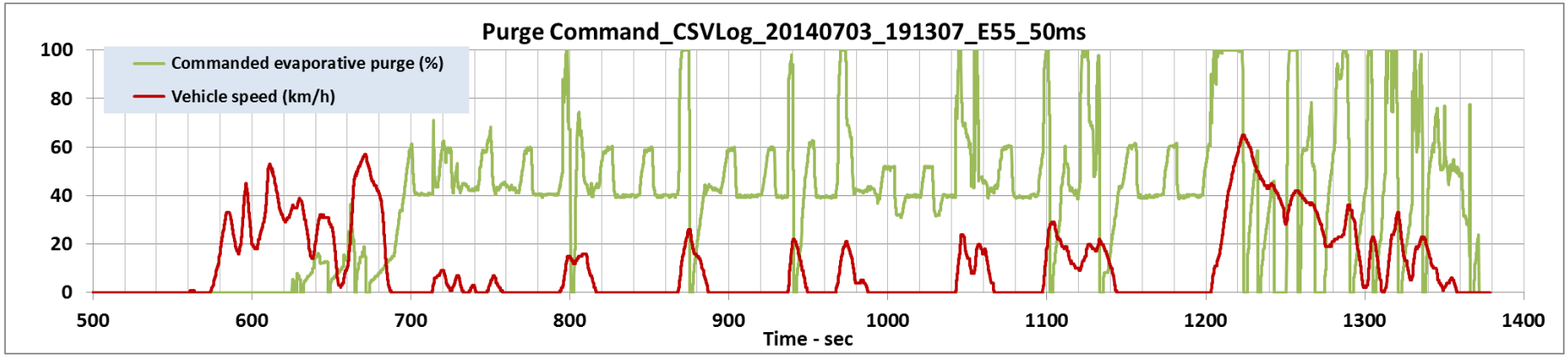
Target values:
1,2 < R < 1,3

Engine conversion looses emission control performance

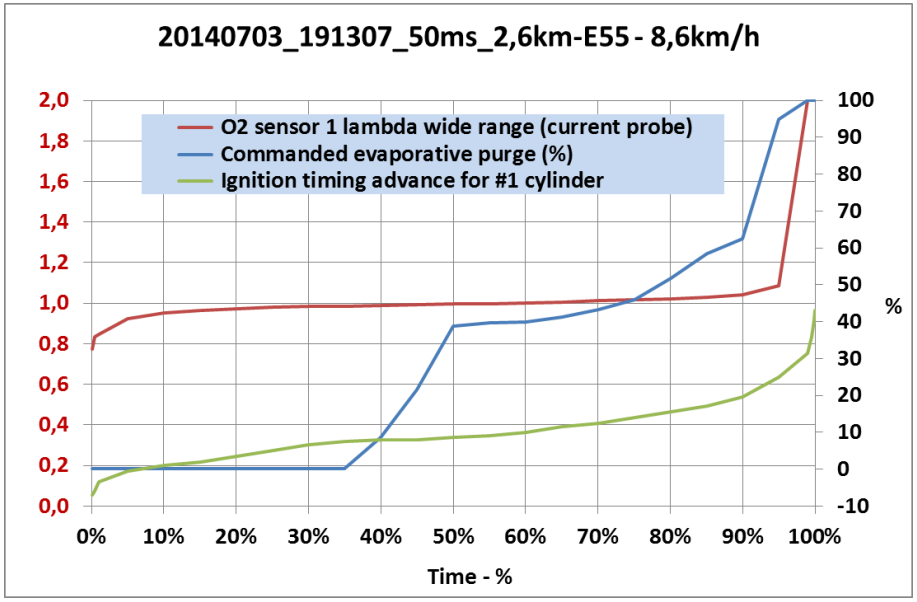
Electronic Management: solution and challenge

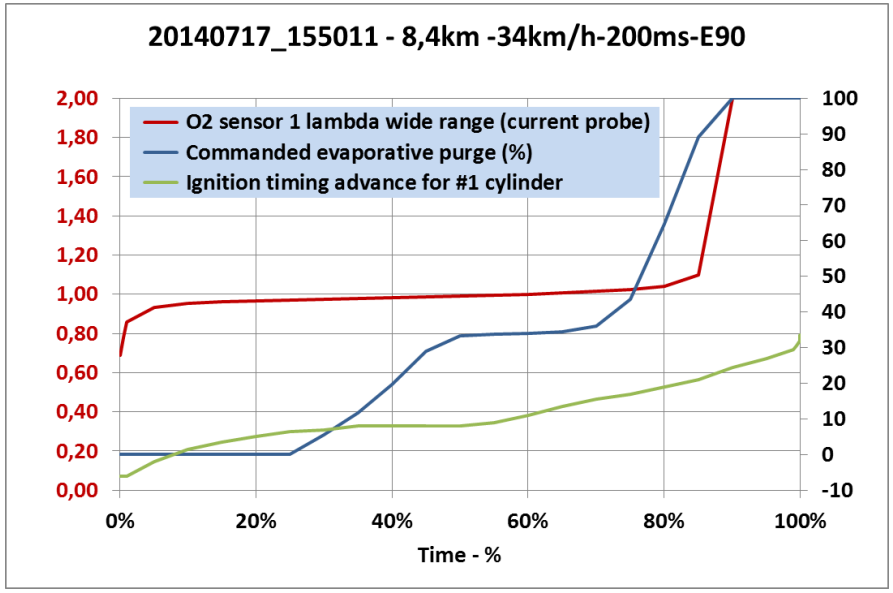
1. **Powerful hardware and softwares control all engine parameters at every second;**
2. **They allow to define emission control strategies, tailor made from the real time statistics, of any vehicle parameter;**
3. **Parameters statistics in real time allows to adapt engine to:**
   - **Ambient conditions, temperature and atmospheric pressure;**
   - **Load, speed and fuel characteristics variations;**
   - **Customer driving behaviour**
   - **BUT IT MAY ALSO ADJUST for driving cycle characteristics, eventually reducing real driving representativeness of certification test procedures**
4. **On board diagnosis – OBD detects engine failures and records maintenance indicator parameters;**
   - **Complement and facilitates annual inspection;**
   - **Allows real time reading of any engine parameter and recording against time and distance traveled.**

Statistical Behaviour and Real Driving



Example: similar behaviour for different driving conditions might be checked in driving cycle

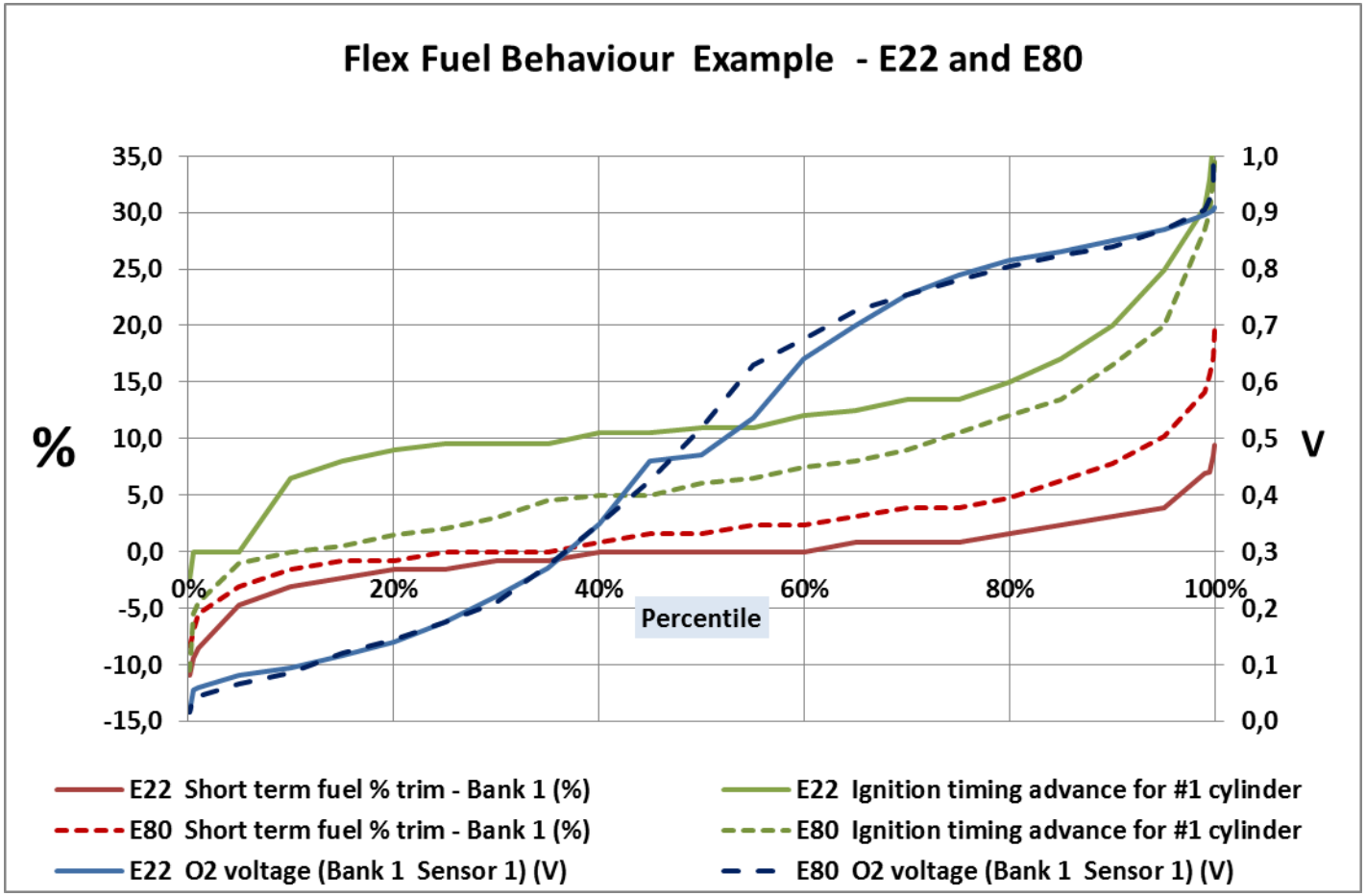




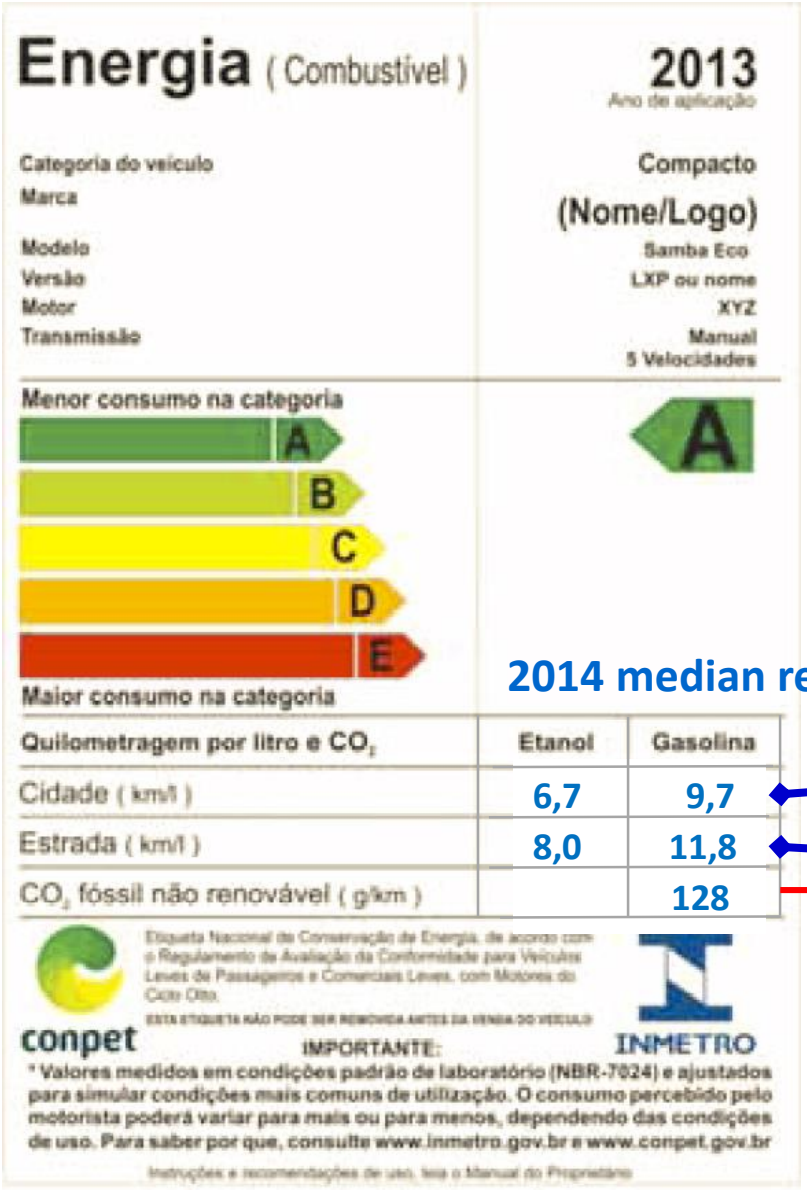
Statistical Behaviour and Real Driving

KEY - calibration parameters statistics may be used to validate driving cycle representativeness of real driving.

Example: different behaviours for different fuels may reveal biased strategies



Test procedures inconsistencies



Energia (Combustível) — **2013** (Ano de aplicação)

Categoria do veículo	Compacto
Marca	(Nome/Logo)
Modelo	Samba Eco
Versão	LXP ou nome
Motor	XYZ
Transmissão	Manual 5 Velocidades

Menor consumo na categoria

Maior consumo na categoria

Quilometragem por litro e CO_2	Etanol	Gasolina
Cidade (km/l)	6,7	9,7
Estrada (km/l)	8,0	11,8
CO_2 fóssil não renovável (g/km)		128

Etiqueta Nacional de Conservação de Energia, de acordo com o Regulamento de Avaliação da Conformidade para Veículos Leves de Passageiros e Comerciais Leves, com Motores do Ciclo Otto.

ESTA ETIQUETA NÃO PODE SER REMOVIDA ANTES DA VENDA DO VEÍCULO

conpet

INMETRO

IMPORTANTE:

* Valores medidos em condições padrão de laboratório (NBR-7024) e ajustados para simular condições mais comuns de utilização. O consumo percebido pelo motorista poderá variar para mais ou para menos, dependendo das condições de uso. Para saber por que, consulte www.inmetro.gov.br e www.conpet.gov.br

Instruções e recomendações de uso, leia o Manual do Proprietário

- **Gaseous emission and fuel consumption has been measured under different bases;**
- **Driving cycle beating is not checked;**
- **Different vehicle versions are used for fuel consumption and emission characterization;**

2014 median results – 2.0 L

Carbon balance

???

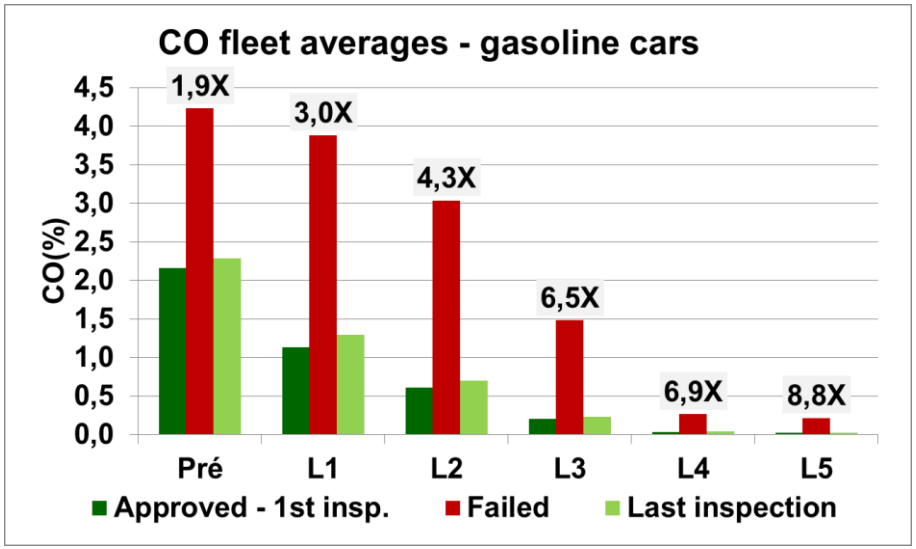
CO_2 - true	Ratio
190	36% (higher)
156	27% to 44%
177 - ave	

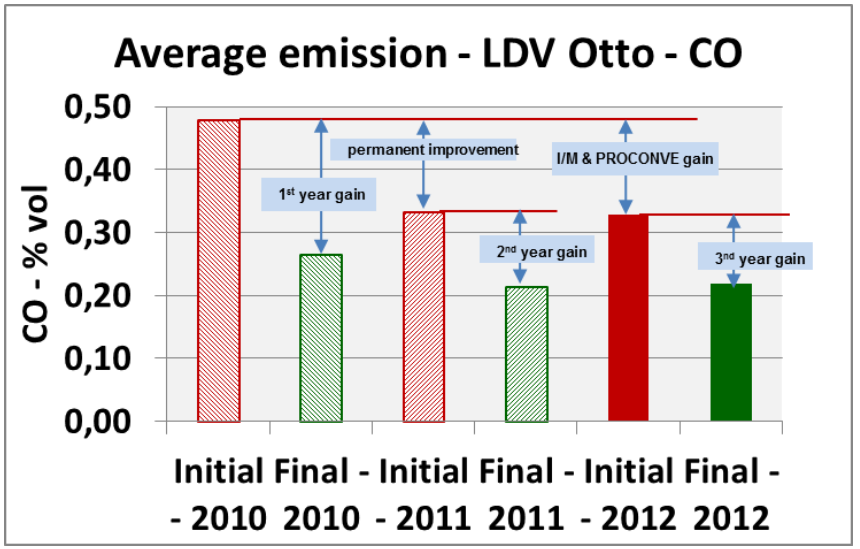
See also http://en.wikipedia.org/wiki/Fuel_economy_in_automobiles

Inspection and Maintenance procedures

1. Simple tests are still efficient for modern cars;
2. Enhanced test procedures may be required ONLY after 2nd reinspecion for tampering control;
3. OBD checks might be included to complement emission inspection:
   - Failures diagnosis report;
   - Readiness for inspection;
   - Measurement of RPM; catalyst, coolant and oil temperatures, etc.;
4. Remote sensing procedures to be adopted for emission measurement , monitoring and auditing;
5. Statistical routines to be established for I&M results interpretation:
   - Environmental benefits estimation;
   - Process auditing;
   - Feedback to Environmental Agency and manufacturers;
6. Social communication Program is a key to I&M success.

I&M Averages by Technology Level





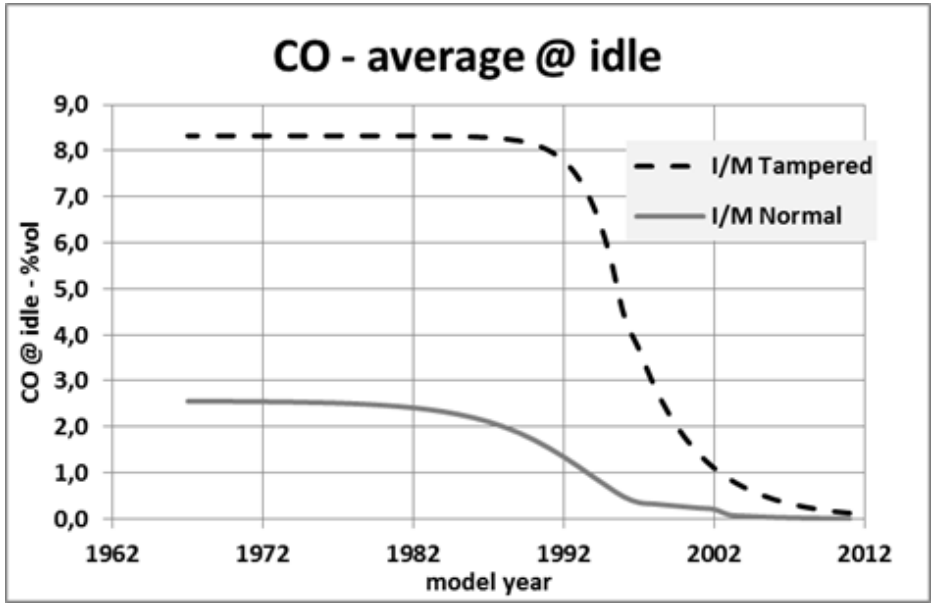
- **FAILED** vehicles show emissions many times higher than **APPROVED** ones;
- Vehicles in the **LAST REINSPECTION** show similar averages as the **APPROVED** ones.

Estimation of Environmental Benefit using two emission inventories for each calendar year:

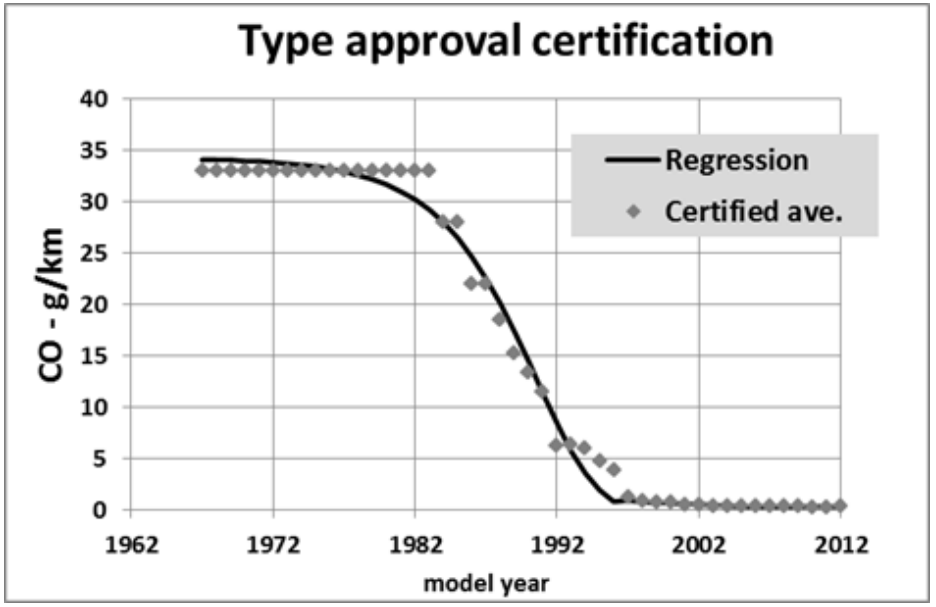
1. **INICIAL inventory: average of Aproved + failed**
2. **FINAL inventory: average of Aproved + last reinspection**

I&M and Type Approval Statistics

millions of cheap measurements with low test representativeness (idle/free accel.)



dozens of expensive measurements with high test representativeness (driving cycles)



Note: Demonstrated in the gasoline Otto cycle CO emission, because this is the most comprehensive fleet

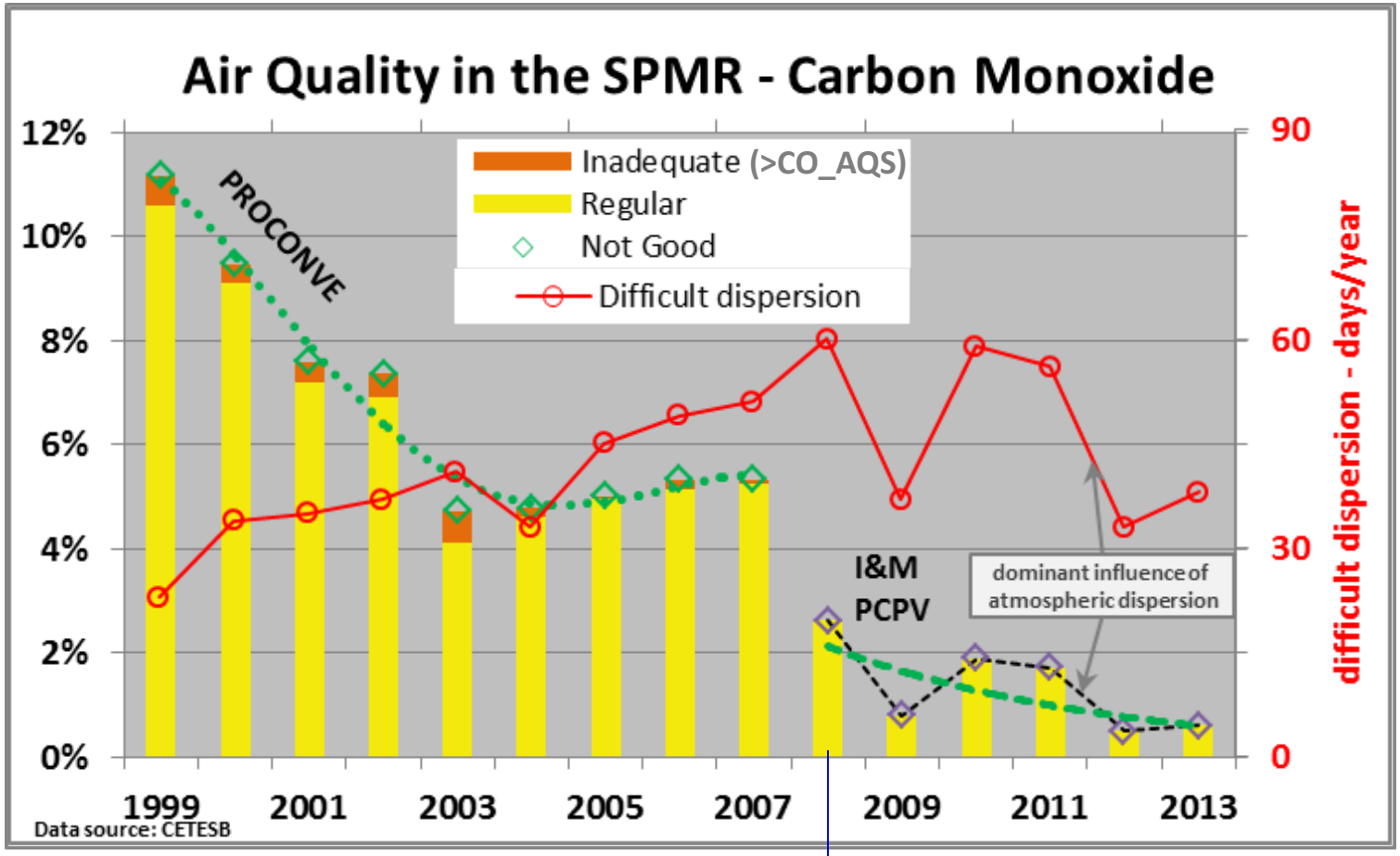
- **Regression lines of averages obtained in I&M inspections show very similar shapes of certification data measured in standard dynamometer driving cycles;**
- **Correlations of these lines show agreement betwen certificated emissions in g/km and in-use normal vehicles, and tampered vehicles as well;**
- **These correlations allow great improvement in inventory estimations.**

Progress of CO levels in the atmosphere

Carbon monoxide is the pollutant most related to vehicle traffic because:

- **it is by far the major source (95% comes from vehicles, mainly Otto cycle in Brazil)**
- **It is monitored by 8 hours moving average, thus sensitive to traffic variations**

Therefore CO is the best indicator to confirm the presented calculations



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CONCLUSIONS

- Ethanol Program helped reducing emissions, especially CO_2 (renewable);
- Only technology improvements and stringent emission standards may assure large emission reductions;
- Engine conversions to alternative fuels loose technological quality;
- Alternative fuels and technologies need OEM development and support;
- Testing procedures in standard driving cycles requires further improvements for engines with enhanced electronic management :
  - key calibration parameters monitoring and
  - comparing to their real world statistics ;
- Fuel consumption and emissions might be determined under the same simulation conditions and vehicle versions to improve consistency;
- Inspection and Maintenance Programs must be implemented and complemented with OBD and Remote Sensing resources, and including statistical routines for evaluation and feedback to Type Approval certification;
- Air quality is improving, but all Programs might be harmonized for better results.

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Muchas Gracias!

Thank you !

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